Space Weather Technical Forecast

Issued on Tuesday, 22 March 2022 at 00:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of G1/Minor Storm Day 3 (24 March). Slight chance of R1/Minor radio blackouts.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Very Low over the past 24 hours, with only B-class flares during this period. There are currently 3 sunspot regions on the visible disc - all appear to have little complexity and are currently quiet.
A Type-II radio burst with an estimated speed of 394km/s was observed with a peak at 21/0549UTC. This was apparently tied to an energetic far-sided Coronal Mass Ejection (CME) seen heading southwest on coronagraph imagery, with the source not visible from Earth. This is a far sided CME, and there were no Earth-directed CMEs observed in the period.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was at largely background levels through the period. The solar wind speed varied between 290-340 km/s. The density was at average to above average levels through much of the period, but increased from 21/1400 UTC to reach a peak of 24 ppcc. The IMF was mostly weak, at 8nT or below. The north-south component varied weakly between +5/-6nT, and was often northward directed, before becoming more southward directed after 21/2120 UTC. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 showed an enhancement in the period, with this likely to be related to the far-sided CME event and the Type-II radio burst. The 10MeV proton flux peaked short of S1 reaching 6pfu at 21/0945 UTC, and is now declining. The 100MeV trace reached a maximum of 0.6 pfu and is very slowly easing.
The high energy electron flux (greater than 2 MeV) has been at Normal Background levels, and the 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold, on a steady trend. Observed fluence at 22/0000UTC was 1.07e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to continue Very Low or Low, with just a very slight chance of M-class flares. Potential new regions are due to rotate onto the visible disc in the coming days, but it is difficult to assess the likelihood of flaring at this stage.

Solar Wind / Geomagnetic Activity: There is one possible Earth directed CME in the forecast, potentially giving Earth a glancing blow around 24/2300UTC. No other CMEs feature in the forecast. There is also one non-persistent coronal hole HSS due, most likely on Day 3 (24 March) - however effects from this are likely to be muted as positive polarity coronal holes are not favoured for geomagnetic response at this time of year.
Geomagnetic activity is expected to be mainly Quiet to Unsettled through much of the period, but with an increase possible on Day 3 giving a chance of Active intervals and a slight chance of G1/Minor Storm intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is

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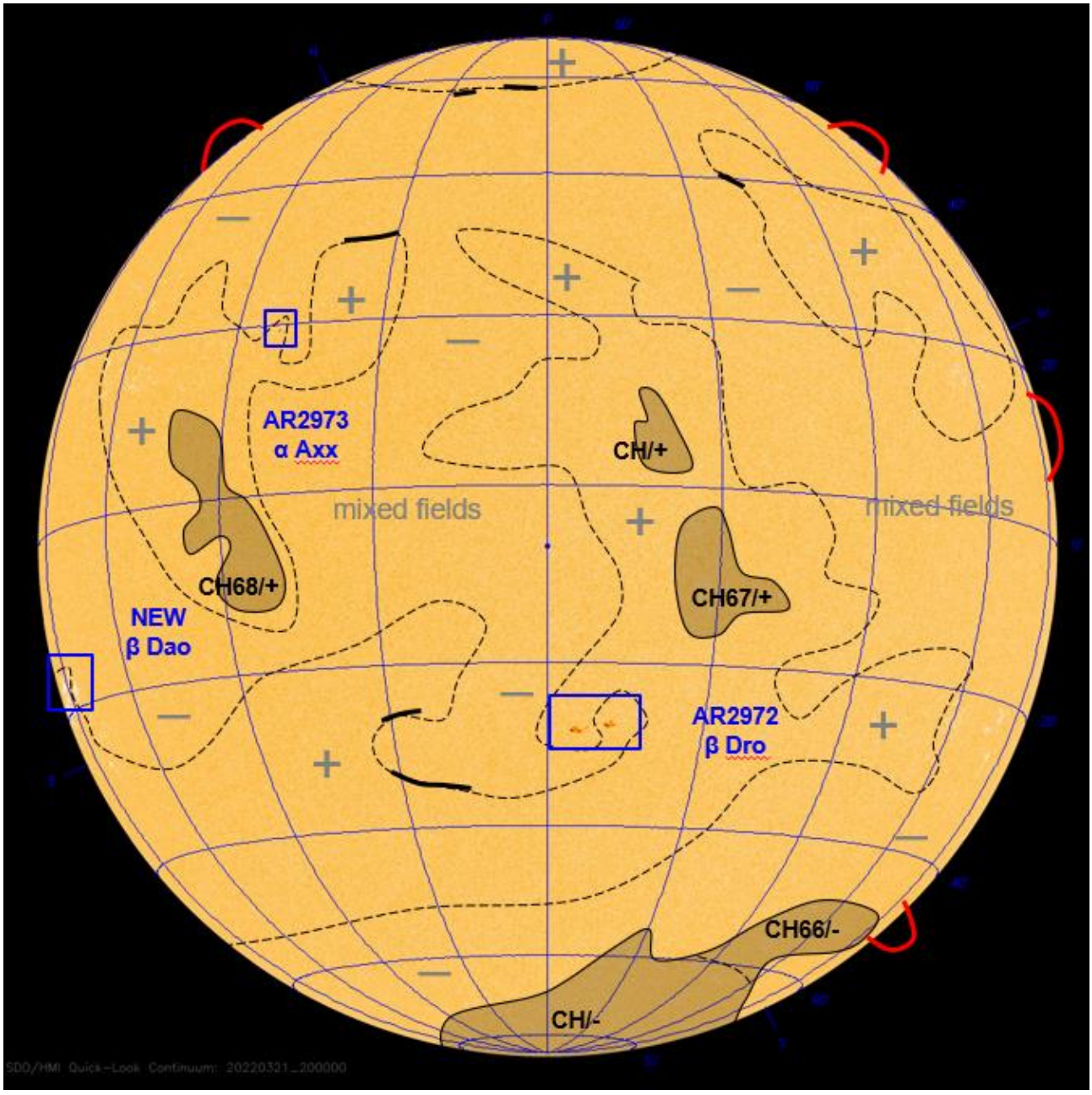
expected to revert to Background levels and is likely to stay that way after the current enhancement.
The high energy (greater than 2 MeV) electron flux is currently at Normal Background levels, and is unlikely to increase in the next couple of days. A rise in flux / fluence levels is possible later in the period after the potential CME / HSS arrivals, but this is very low confidence and fluence levels are most likely to stay well below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one possible Earth directed CME in the forecast, associated with the 20/0745UTC C4.6 flare which emerged from the plage remnant of Ex-2971 in the northeast quadrant. This has been assessed in as possibly giving Earth a glancing blow, with this due around 24/2300UTC. No other CMEs feature in the forecast.

There is also one non-persistent coronal hole HSS due, most likely on Day 3 (24 March) - from CH67 west of centre disc. This is both small and of positive polarity, and effects are likely to be muted as positive coronal holes are not favoured for a geomagnetic response at this time of year. However, the combination of the possible CME and coronal hole HSS may give a slightly enhanced response. STEREO A data appears to be polluted by a passing transient, but so far doesn't show any sign of increased wind speeds however.

Geomagnetic activity is expected to be mainly Quiet to Unsettled through much of the period, but with an increase possible on Day 3 giving a chance of Active intervals and a slight chance of G1/Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/22:40 UTC	Partial	Plage from ex-2971	N09 E20	210 km/s	24/2300 UTC	Slow CME following C4 flare. Most ejecta directed N and E of the Sun-Earth line. Limited shock expected.

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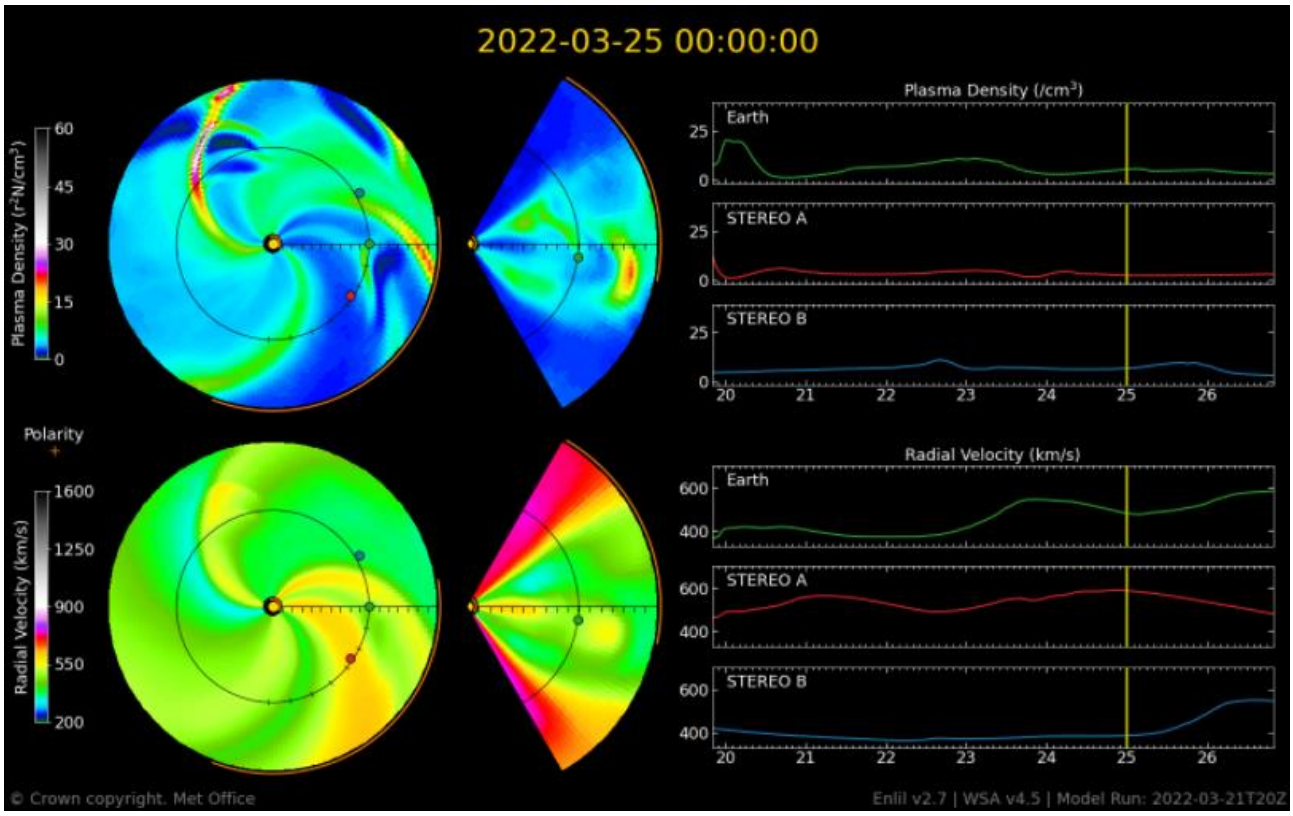
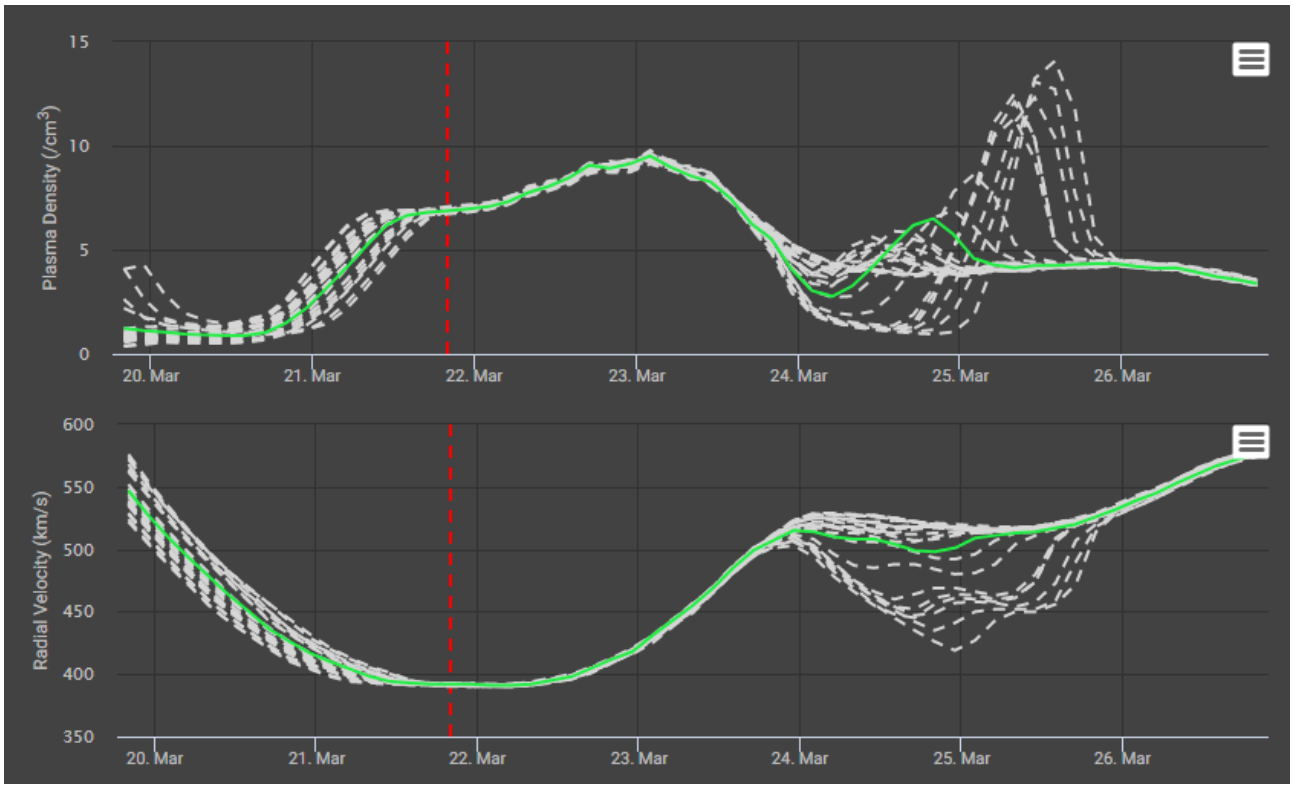
Figure 2: Enlil model and ensemble, showing a possible CME arrival later on 24 March.





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Radio Blackouts - X-Ray Flares:
Solar activity has been Very Low over the past 24 hours, with the current visible sunspot regions quiet at the present time. AR2972 (Dro/Beta) just west of centre disc has grown somewhat in the last 24 hours, with penumbra becoming visible on both the leading and trailing spots. It currently has a fairly simple magnetic structure however. A new region has rotated onto the southeast limb. Although foreshortening near the limb makes it difficult to classify, it currently appears to be a Dao/Beta classification. AR2973 in the northeast has faded significantly and is now barely visible.

Significant X-ray flares are therefore unlikely, with just a very slight chance of low level M-flares. There are also some potential new sunspot regions due to rotate onto the visible disc in the next couple of days, however until we can properly see the new regions it is difficult to assess the likelihood of flaring at this time.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

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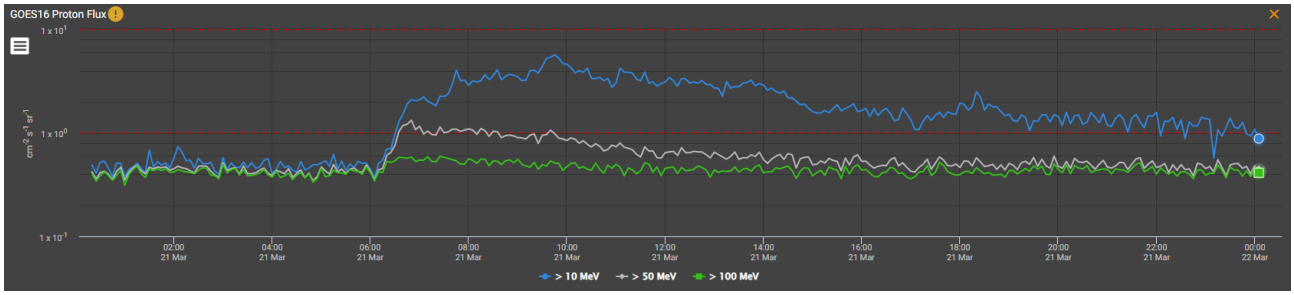
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES-16 showed a slight enhancement in the past 24 hours, although the source for this event is unclear for being far-sided in origin. This presents some difficulty in forecasting a repeat of this event, as it is not clear whether the flare/CME was generated by an active region or a filament and we can't see how the source has evolved since. Proton enhancements from the current front side sunspot regions are unlikely at this time.

The proton flux levels are now subsiding, and as such the chances are that levels will return to background with further enhancements considered unlikely.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: Proton trace from GOES-16, showing slight enhancement at all energies, but below warning thresholds. This is now declining.



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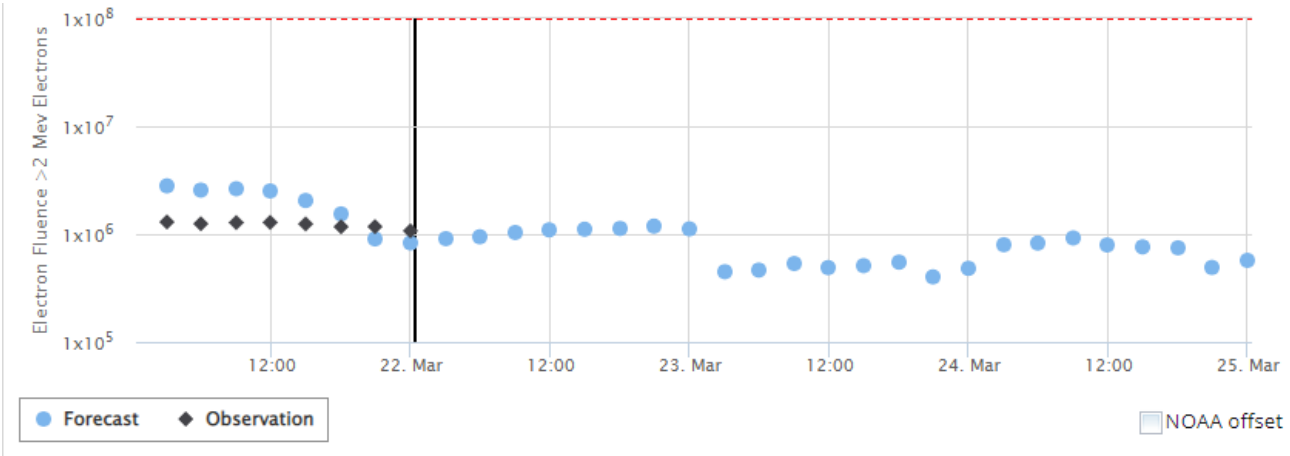
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux as observed at GEO by GOES-16 is currently at Normal Background levels, with any significant enhancement in the near term unlikely. The next potential enhancement may come from CH67/+, which is due to arrive on Day 3 (24 March), once the initial CIR effects have waned. However, this feature is expected to be weak with little geomagnetic response, so is unlikely to raise electron levels enough to reach the Active (1e8 integrated pfu) fluence threshold in the forecast period. The general trend on MOSWOC REFM is currently flat and well below Active, with this accepted.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM showing fluence staying well below the Active threshold, which is likely to be good guidance.



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